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ABSTRACT

The study examined the effectiveness of a program to improve the cognitive skills of 91 hearing impaired college students. Experimental students received systematic cognitive instruction focusing on specific generalizable skills during the experimental period, several times per week, in the contexts of their regular college classes. Instructors of the experimental group were given special training over a 2-year period in the methodology of the program, Instrumental Enrichment. Results indicated that cognitive instruction of this nature produced statistically significant improvement for experimental subjects in tests measuring logical reasoning, reading comprehension, math concepts, and math computation. A process analysis of interviews with individual experimental students and their instructors also indicated that students began to demand more verbal elaboration, to become more careful in checking for error in their work, and to ask for verification from each other on points made during classroom discussions. Recommendations are made for expanding systematic cognitive skill instruction in universities. Systematic training of college instructors was concluded to be a fundamental prerequisite for the implementation of such programs. (Author/DB)

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Improving Thinking Skills in Deaf College Students

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ABSTRACT

This investigation focused on the serious need for active programs in improving the cognitive skills of hearing-impaired college students. Ninety-one entering students at Gallaudet University were identified as experimental students, and were matched with 91 students as controls for the experiment. Experimental students received systematic cognitive instruction focusing on specific generalizable skills during the experimental period, several times per week, in the contexts of their regular college classes. Instructors of the experimental group were given special training over a two-year period in the methodology of the program, Instrumental Enrichment. Results indicated that cognitive instruction of this nature produced statistically significant improvement for experimental subjects in tests measuring logical reasoning, reading comprehension, math concepts, and math computation. A process analysis of interviews with individual experimental students and their instructors also indicated that students began to demand more verbal elaboration, to become more careful in checking for error in their work, and to ask for verification from each other on points made during classroom discussions. Recommendations are made for expanding systematic cognitive skill instruction in universities; systematic training of college instructors was concluded to be a fundamental prerequisite for the implementation of such programs.

INTRODUCTION

Background

Results of recent National Assessment of Educational Progress Tests (NAEP) indicate that students on a national level are faltering in problem-solving skills. Instructors who work with hearing-impaired students frequently express concern and frustration about their students' deficiencies in problem-solving skills, and in understanding and manipulating higher order concepts and abstractions, as indicated in both classroom and written work. That concern often relates to difficulty with such critical cognitive skills as: manipulating more than one variable, conceptualizing what a textbook or

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journal author is saying, forming conclusions, dealing with hypothetical data, and spatial reasoning.

Yet, research with hearing-impaired persons has documented that there are no basic differences between their range of cognitive abilities and that of the general population, and that any inferiority in cognitive performance may be accounted for by experiential and linguistic deficits as well as by communication handicaps (Levine, 1976, 28).

During recent years, however, a specially developed program entitled Instrumental Enrichment (Feuerstein, 1978) has become available in the United States, developed by the Israeli Piagetian scholar, Reuven Feuerstein. This classroom intervention program for adolescents and adults uses content-free paper-and-pencil exercises to correct deficient cognitive functions and provide the prerequisites for learning and problem-solving. Specific skills enhanced through the program include: analytic perception, projection of virtual relationships, orientation in space, comparison, temporary relationships, hierarchical relationships, syllogistic thinking, categorization, synthesis, and sequential progression.

Review of the Literature

Studies in cognition in hearing-impaired persons have been numerous in recent years. After an initial period of research focusing on I.Q., the center of attention now is on the processes involved in cognition and perception. It appears to be generally accepted that hearing-impaired persons have the normal range of intelligence when tested on the performance, rather than the verbal, subtests of various I.Q. instruments (Drever & Collins, 1928; Vernon, 1968, 7 and 8). When the influence of age is controlled, statistical data on hearing-impaired children indicate strong relationships between

achievement test scores and variables such as age-of-onset of hearing loss, cause of loss, degree of loss, additional handicapping conditions, ethnic background, and type of special educational program (Jensema, 1975).

The literature on the improvement of cognitive skills in the college-age learner strongly supports the efficacy of specific and planned training in those skills. Even minimal training in cognitive strategies has resulted in long-term benefits in college-level students (Dansereau, et al., 1975). The literature demonstrates that cognitive skills training is effective (Weinstein, 1977; Weinstein, et al., 1980; Weinstein, et al., 1981).

If we accept the fact that certain specific cognitive deficiencies do exist for hearing-impaired persons but that no evidence suggests less than the normal range of intellectual potential among them as a general group, then it is apparent that a specific program of activity in an educational setting holds significant promise for improvement of these critically important generic skills. In addition, a program which was originally developed to improve the performance of disadvantaged hearing learners who had some of the same deprivation of thinking skills opportunities as hearing-impaired learners, may well be specifically the type of program which is adaptable for this special purpose.

The Intervention Program

The program, Instrumental Enrichment (IE), was developed originally in Israel by Reuven Feuerstein, a student of Piaget, in response to the need for Mediated Learning Experiences (MLE) for culturally disadvantaged groups emigrating to Israel. Mediation is that activity in which a person assists a learner in interpreting experience and in learning strategies for problem-solving. Feuerstein developed the program known as (IE), as a

supplement to the regular curriculum in which students focus on paper-and-pencil exercises of increasing complexity designed to develop and enhance specific cognitive skills at the representational and symbolic levels of thinking and to enhance the learner's capacity to learn.

IE does not assume that generalization will automatically occur; rather, a critical element in the instructional methodology in IE is the "bridging" exercises in which the teacher overtly and actively promotes transfer by the student of cognitive skills to both real-life and curricular situations, through discussion for insight. IE is, then, based on the concept of cognitive modifiability which assumes it is never too late in an individual's life for modification of cognitive structures.

Prior Research Results

To date, IE had been used on a limited basis with hearing-impaired student populations. Prior experiments testing the IE program with hearing-impaired adolescents at the Model Secondary School for the Deaf at Gallaudet University have indicated that students measurably improved in the skills of reading comprehension, mathematical computation, systematic approach to problem-solving, organization of solutions to subject matter problems, and abstract thinking (Martin and Jonas, 1986). Another one-semester pilot study with Gallaudet undergraduate students in teacher preparation using the identical program showed similar improvement in precision, ability to compare, ability to explain, and diagnosis of errors in their written work (Martin, 1984). The positive results from these separate implementations of the IE program indicated a strong rationale for a more widespread and systematic research project with hearing-impaired students of the scope described below.

METHOD

General Procedures

The training procedure for instructors involved six full-days of instruction in the cognitive materials for each year of the two-year Project. Thus, the instructors themselves experienced cognitive modification as they prepared to provide Mediated Learning Experiences (MLE) for their own students. An example of MLE for which teachers were trained, was as follows:

1. Students in an English course carried out an IE task involving the comparison of pairs of words with somewhat similar meanings, and were asked to delineate the specific differences and similarities between the words.

2. The instructor then discussed with the students the mental processes which they used to solve these problems (looking at the entire problem first; fine discrimination between words that appear to have the same meaning; keeping in mind several sources of information; using what is known, what is seen, and what can be inferred; and checking for error). This discussion was considered metacognitive.

3. The instructor then discussed with students how that particular skill of comparison could be applied (or "bridged") to the subject matter of the course, e.g., in English--comparison of two characters in a narrative, comparison of two pieces of writing which are designed to communicate the same message, comparison of two modes of communication for the hearing-impaired learner.

4. Finally, the instructor later in the context of the English course referred back to the skills of comparison learned from these exercises, as a way of reinforcing the importance of the comparison process.

During academic year 1985-86, experimental students had regular (at least 90 minutes per week) instruction in the Instrumental Enrichment program, focusing on the six cognitive skills of: projecting virtual relationships, orientation in space, analytic perception, comparison, creating and following instructions, and categorization.

During the academic year 1986-87, participating subjects had regular instruction in the cognitive skills of temporal and spatial relationships,

numerical progressions, hierarchical relationships, synthesis, and logical reasoning. Intervention occurred in the context of regular course work by regular instructors who had special additional training in the IE program as discussed above.

Groups

In the Fall of 1985 (Year One), 91 experimental subjects were identified in the classes of the seven experimental instructors who made a commitment to training in the methods of IE--the experimental treatment. Ninety-one matched control subjects were also identified.

As a result of naturally-expected student attrition at the college level, four different lengths of experimental intervention exposure occurred--a four-semester experimental group, a three-semester experimental group, and two two-semester groups (1985-86 and 1986-87). The control group, of course, consisted of individuals who throughout the two-year period had no exposure to the experimental treatment.

Criterion Measures

Demographic data were collected on all experimental and control subjects in the Fall of 1985, including: age-of-onset of hearing loss, decibel loss in the better ear, and gender. Pre-tests were administered to both groups, including: Raven's Standard Progressive Matrices (Raven, 1960), the Gallaudet University Writing Placement Test, the Effective Study Skills Test (Brown, 1964), the Study Skills Survey (Brown, 1983), and the Self-Concept as a Thinker Survey (Martin, 1981); in addition, scores on entering students on the Stanford Achievement Test Hearing-Impaired (SAT-HI) (Madden, 1972) were obtained for the subtests of Reading Comprehension, Math Concepts, and Math Computation.

Post-test measures administered to both experimental and control subjects were: the Raven's Standard Progressive Matrices; and the SAT-HI subtests on Reading Comprehension, Math Computation and Math Concepts; in addition, individual interviews of 20 randomly selected experimental students, and interviews with all experimental group instructors took place at the end of the experimental period.

RESULTS

Carry-over Effect

The original grant proposal for this project indicated that the implementation would occur over a two-year period, first with a group of entering students and their instructors, and then with that same group of students in their second year and their instructors at that time.

The question arose, "What persisting change, if any, can be seen among the first-year instructors after they were no longer required to implement the thinking skills program?" That question is not easily answered. However, during 1986-87, while the experimental group was in their second year, the investigator examined the activity of first-year instructors (from 1985-86) as they began to teach a new entering group of students (who were not a part of this experiment). These instructors chose to continue their own training in IE in second-year instruments and also voluntarily implemented IE with their new group of entering students.

Analysis of pre- and post-test results in 1986-87 in first-year algebra--a subject taught by two of these instructors--in comparison with other algebra classes taught by non-IE instructors indicated a statistically significant difference (p .01) in favor of the students in these two experienced IE instructors' classes.

Interview Data

As originally planned, the investigator also interviewed randomly selected experimental subjects as well as the instructors in the experimental group. These data are used to assist in the interpretation of the statistical findings and to broaden the base of information on the results of the experiment beyond paper-and-pencil instruments.

1. Students

The student interviews took place during Spring 1987, well into the final semester of the experimental treatment. Students were asked to respond to the question, "In what ways have you changed your thinking since you started to use Instrumental Enrichment?" Five students of the twenty randomly selected experimental subjects responded that they were not aware of any change; an additional two students expressed only that they were concerned with the amount of time that Instrumental Enrichment seemed to "take away" from learning English. The remaining students (13) all replied in some form that they believed that their thinking patterns had become more careful or systematic or less impulsive. A sampling of the responses of this latter sub-group are presented below to demonstrate the support for this interpretation:

Student	Statement
A.	"I found that I started to slow down before I guessed at an answer to a problem."
B.	"I think I started to look at the whole thing instead of the parts of a problem."
C.	"I think IE has been good for me--I can think better."
D.	"It takes me a little longer, but I think I get more right answers now."
E.	"I try to look for the reasons underneath the answers now before I write an answer."

2. Experimental Instructors

During the interviews with the experimental instructors, the key question was, "What types of responses to the program did you see happening in your students in the experimental group?" Instructor responses to this question helped to elaborate further on the above student responses. Among the instructors' observations was the clear trend that experimental students by the period of March 1987 began to demand that their instructors give them further verbal elaboration on any response, thus reflecting the same elaborative style that the instructor had been trying to model for them. For example, students were reported by experimental instructors to demand this reasoning both from each other and from the instructor with words such as:

A. "Explain it to me, please."

B. "Give me the evidence for that."

C. "Could I have another example, please?"

D. "I think I have the idea; let me give you an example and see if I know it now."

E. "How does that connect with what I already know?"

Instructors reported that no such demands were made by experimental students during the first semester of the experiment. Students were also reported by experimental instructors to argue with one another over points during class, whereas previously they had merely accepted what the instructor had said or what each other said without question. It is clear from these sets of quotations that verbal elaboration behaviors were enhanced by the program; no such responses were reported from students in non- Instrumental Enrichment classes by experimental group instructors.

The second key question in the interviews of IE faculty was, "What overall changes do you see as a result of the experiment?" The following points were made by IE faculty interviewees:

A. Students in the experimental group began to feel the "strength" of their reasoning powers.

B. The students in the experimental group moved further ahead into higher level English and math than had been the case in previous years with similar groups that did not have Instrumental Enrichment.

C. Students demonstrated more confidence in themselves during examinations.

D. Students began to be able to use more than one piece of information at a time in activities requiring that behavior.

E. Test scores on teacher-made tests demonstrated that students had begun to "reason better."

F. Students stopped giving up on difficult academic problems or being depressed about their difficulty.

G. Students became better notetakers; they began to ask the instructor to stop and allow them to take notes instead of the instructor having to stop and remind them to take notes (this is an important issue in teaching deaf students, who are normally not able to take notes during a lecture because of the need for visual attending).

H. Students at first resented the non-verbal materials in the program because they felt that they were for younger students; but by the end of the third semester, they expressed that they saw the value of those and began to ask for more practice in the non-verbal instruments as well as in the verbal instruments.

I. Instructors said that they believed their own style of teaching had changed permanently as a result of the training in the direction of: allowing more "wait-time" for student responses in discussions, using more cognitive terms in their teaching, and demanding higher-level responses from their students during discussions.

Thus, these data also demonstrate that important changes were taking place beyond what was noted in the test scores reported earlier.

SUMMARY OF TEST RESULTS

A brief series of summarized results on the statistical comparison of IE and control groups is presented here for all data and several composite case study analyses:

1. The gains on the Raven's Standard Progressive Matrices of logical reasoning were significantly higher for the IE group as compared to the control group.

2. The scores on the SAT-HI Reading Comprehension test are significantly higher for the IE group as compared to the control group.

3. The scores on the SAT-HI Math Concepts test are significantly higher for the IE group as compared to the control group. Also, the length of IE exposure (two versus four semesters) significantly favors longer exposure.

4. The scores on the SAT-HI Math Computation test are significantly higher for the IE group as compared to the control group.

5. In the entire group (both IE and control combined), males scored higher than females on the Raven's pre- and post-test, but both sexes gained the same amount of points. Males also outscored females on Math Concepts and Computation.

6. Looking at the IE group only, males performed better than females on the gain score of the Raven's Progressive Matrices, the Math Concepts, and Math Computation tests.

7. Within the top 25% of the IE score distributions on the Raven's Standard Progressive Matrices and the SAT-HI battery of tests, representatives of both sexes, and all levels of hearing loss did well enough to be included on one or more of these post-test measures.

8. Most often the high-achieving IE student did well on the Raven's Standard Progressive Matrices (i.e., gained 3 or more points) and had 4 semesters of exposure to IE materials.

CONCLUSIONS

From the combination of the statistical and anecdotal data reported and analyzed above, a number of conclusions are drawn by the investigator as follows:

1. Two years of intervention with a systematic cognitive skills program is clearly more productive than a one-year intervention in terms of changes in cognitive behavior and academic achievement.

2. For the young adult learner in the collegiate environment, a systematic cognitive skills program places the student in situations where they can begin to feel that they can think, which is an important factor in their self-confidence as learners. This conclusion is especially critical in terms of the deaf college student, who frequently has a problem with self-confidence in comparing himself or herself with hearing students.

3. No significant alterations of sequence in cognitive skills instruction is needed for adapting cognitive-skill programs for hearing-impaired, as compared with hearing, college students.

4. This program of systematic cognitive instruction leads students to mediate for each other, to the point where this peer mediation gradually becomes a supplement to the mediation carried out by the instructor. Again, this conclusion is important in relation to the mutual-assistance goal of hearing-impaired college students being able to support one another and become somewhat independent of older mediators, whether they be hearing or deaf.

5. Instrumental Enrichment as an intervention assists in making the link between the visual and the verbal code systems for the hearing-impaired learner; this conclusion was based on the observed easy interaction back and forth between those two modalities on the instruments as noted by experimental-group instructors, by comparison with their observations of the same students at the beginning of the experiment. Once again, this conclusion is fundamentally important in regard to the hearing-impaired college student who must make transitions on a regular basis between those two modes if he or she is to be successful in the collegiate learning environment and in the world beyond college.

6. The implementation of a cognitive skills instruction program at the college level is made difficult by the flexible scheduling and optional course election that is permitted in the collegiate environment; systematic ensured instruction in cognitive skills is far more difficult in that environment than in the secondary school. Cognitive skills instruction should therefore be made a regular part of at least one course in any hearing-impaired college student's program so that all students have this systematic experience.

7. The majority of deaf children in our society are the children of hearing parents; such was also the case with the students in this investigation. The idiosyncratic cognitive style of the hearing-impaired student who has hearing parents--the necessity from an early age for moving back and forth between a hearing and a deaf world--can lead to some inhibitions on the effects of cognitive skills instruction compared with hearing students. Thus, the intervention carried out in the current experiment reflected the same time-frame and style as normally takes place with hearing students, but the results in the current case were less marked, due in part to this variable of style.

8. All, not some, hearing-impaired college students can benefit from cognitive skills instruction; the positive changes noted in experimental subjects were general and not limited to those whose pre-test scores or individual characteristics fell in any low, middle, or high range.

9. Cognitive skills instruction must be given a legitimate and administratively supported position within the curriculum for hearing-impaired college students in order for systematic improvement to occur in the thinking patterns of these students.

10. The apparent strength of the gains shown by the one-year intervention group (1985-86), shown on their tests in the spring of 1987, indicate that the cognitive modification that took place one year before had a lasting effect even though it was small; it did not disappear with time. Although detailed analysis was not carried out because it was beyond the required scope of this project, three subconclusions may be drawn from these admittedly limited data:
    a. Trained IE instructors tend to persist in their interest in implementing the teaching of thinking skills.
    b. Students in the classes of experienced IE teachers show significant gains over these in other classes, even though the instructors are not required to implement IE.
    c. IE as a method of teaching thinking skills has the clear potential to become institutionalized as a part of the college curriculum if instructors are appropriately trained and have continued access to needed materials.

    This apparent potential for institutionalization is a critical element in the long-range thinking behind this project and is a truly encouraging indication for the improvement of cognitive skills.

11. Any cognitive skills experiment which uses the classroom as the unit of intervention is confounded by the fact that instructor style (irrespective of systematic instructor training) can have some effect on student results. The degree to which an instructor feels a level of comfort with taking time for cognitive instruction within the regular curriculum can have a direct effect on the success of implementation of cognitive skills instruction in a college course.

RECOMMENDATIONS

Based on the findings and conclusions of this study, the following recommendations are made at this time for the implementation of cognitive skills instruction with college-age hearing-impaired students:

1. Wherever possible, cognitive skills instruction should begin at an earlier age than the college age so that college environments can reinforce rather than teach for the first time these essential skills. Colleges should take the leadership in promoting this instruction in secondary schools.

2. While it is administratively efficient to have cognitive skills instruction be the responsibility of one single academic department in which students must take courses (e.g., English), it is far better to have cognitive skills instruction embedded <u>across all subjects</u> and across a number of departments to which students will have exposure. If departments work in a complementary manner in regard to the responsibility for cognitive skills instruction, the burden is spread and the student benefits by seeing the connections of generic cognitive skills to a variety of subject areas.

3. The cognitive skills instruction program in an environment for hearing-impaired college students should be supplemented (but not supplanted) by a thinking skills laboratory. In such a "lab," students would have an opportunity for reinforcement of the cognitive skills being taught in their regular courses but now on a one-to-one basis with a separate skilled instructor during after-class hours.

4. Instructor training in cognitive skills instruction should take place one full year prior to their being expected to implement it systematically within their subject areas for students.

5. Special workshops for college administrators and department chairs should take place on cognitive education so as to ensure administrative support for faculty who take the "risk" of using valuable course time for incorporation of cognitive skills instruction.

It is essential that the educators of hearing-impaired students at all levels, but especially at the college level, now take note that the cognitive potential of such students can indeed be raised--this conclusion is the most essential and hopeful one for the future of the hearing-impaired learner.

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